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December 6, 1994

William F. Caton, Acting Secretary
Federal Communications Commission
Room 222 -- Mail Stop 1170
1919 M Street N.W.
Washington DC 20554

Re: Petition for Rule Making:

Amendment of Section 15.247(a)(1)(ii) of the Commission's Rules on Spread Spectrum Operation

Dear Mr. Caton:

On behalf of Symbol Technologies, Inc. and pursuant to Section 1.401 of the Commission's Rules, I am filing herewith the original and four copies of the above-referenced Petition for Rule Making.

If there are any questions about this filing, please call me at the number above.

Respectfully submitted,

Mitchell Lazarus

cc (w/encl): Richard M. Smith, Chief
Bruce A. Franca, Deputy Chief
Dr. Michael J. Marcus
FCC Office of Engineering and Technology

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Symbol Technologies, Inc.

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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington DC 20554

In the Matter of	)	
	)	
Amendment of Section 15.247(a)(1)(ii) of the Commission's Rules on Spread Spectrum Operation	)	RM-_____

TO: The Acting Secretary

PETITION FOR RULE MAKING

1. Pursuant to Section 1.401 of the Commission's Rules, Symbol Technologies, Inc. ("Symbol"), a major manufacturer of Part 15 spread spectrum data communications equipment, hereby petitions the Commission to amend Section 15.247(a)(1)(ii) to reduce the minimum number of hopping frequencies from 75 to 15 and to increase the maximum permissible bandwidth. As explained in more detail below, this change will have the following advantages:

-- ***Export market***. By aligning U.S. standards more closely with European standards, the proposed rule will permit U.S. manufacturers to produce the same equipment for domestic use and for export to Europe. This will reduce the cost of exported goods and should increase U.S. exports to Europe.

-- ***Wireless LANs***. Equipment manufactured under the proposed rule will be capable of substantially higher data speeds than can be achieved under the present rules, and so will help to satisfy customer demands for high speed and low cost in the emerging market for wireless computer networks.

-- ***Lack of interference***. The proposed rule will not significantly increase the threat of interference to other users of the band.[1/]

-- ***Proposal for 2402-2417 MHz***. In the event the Commission adopts its pending proposal to auction the 2402-2417 MHz band for commercial use,[2/] the proposed rule change will enable spread spectrum users to avoid the need to use that part of the band while still achieving adequate data rates.[3/]

Background

2. Symbol is the leading manufacturer of portable bar code driven data transaction systems, with 2.5 million scanners and hand-held computers installed. Symbol designs, manufactures, and markets bar code laser scanners, portable computers, and radio frequency data communications networks that are used as strategic building blocks in technology systems for retail, warehousing, distribution, manufacturing, package and parcel delivery, and other industries.

3. Symbol's products include the "Spectrum One" network, a real time data collection system that uses Part 15 spread spectrum transmission. Spectrum One and products that communicate over the network constitute the fastest growing

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[1/] In addition to Part 15, other presently authorized uses of the band are Government radiolocation, the Amateur Radio Service, and ISM. See 47 C.F.R. § 2.106.

[2/] Allocation of Spectrum Below 5 GHz, ET Docket No. 94-32, Notice of Proposed Rule Making, FCC 94-272 at ¶¶ 8-10 (released Nov. 8, 1994) ("Notice in ET Docket No. 94-32").

[3/] Symbol has no objection to the Commission's proposal for 2402-2417 MHz, but notes that the proposed lack of technical constraints for new services may result in the introduction of services that are not compatible with spread spectrum operation. See id. at ¶ 10.

segment of the retail automation market. More than 50% of all new installations of wireless data collection systems are based on spread spectrum technology. Such systems using relatively high data rates, as opposed to the lower data rate obtained on narrow band licensed channels, have revolutionized this industry. Typical Spectrum One applications include retail pricing, inventory control, and incoming receiving control; warehousing and distribution; tracking of raw materials, work in progress, and finished goods in manufacturing, as well as inventory control, production tracking, and quality assurance reporting; and tracking of shipments by package and parcel delivery providers, passenger airlines, the US Postal Service, and freight trucking. These systems automate tasks in real time, provide dramatic speed improvements, and increase accuracy.

4. The advantages of this technology will soon come to wireless high-speed computer networks ("wireless LANs"). The Institute of Electrical and Electronic Engineers ("IEEE") is sponsoring an industry-wide standard (IEEE 802.11) for wireless LANs using spread spectrum in the 2400-2483.5 MHz band. Several of the major computer and communications manufacturers, including Apple Computer, AT&T, GEC-Plessy, IBM, Motorola, Raytheon, and Symbol, are playing lead roles in these deliberations. Adoption of the standard is expected in 1995, and will greatly accelerate the demand for wireless spread spectrum communications at 2400-2483.5 MHz.

5. The earlier IEEE standards for wired local area networks -- 802.3 (Ethernet) and 802.5 (Token Ring) -- have had profound economic effects, producing tens of billions of dollars in investment and revenue and creating several large companies to serve the emerging markets, including Novell, 3COM, Cisco, and Synoptics. There is every reason to expect that IEEE 802.11 will have comparable effects on the market for wireless LANs. A well-respected trade publication projects the following growth for wireless LANs:[4/]

	Revenue (millions)	**Growth (percent)**
1993	$100.7	127.8%
1994	206.1	104.7
1995	359.7	74.5
1996	565.3	57.2
1997	836.9	48.0
1998	1,155.9	38.1
1999	1,522.1	31.7
2000	1,923.1	26.3

6. Other spread spectrum applications will soon eliminate check-out lines in supermarkets and discount stores by letting customers scan their own purchases in the aisle. The same technology is also helping to improve performance and hold down costs in the health care industry: With bar-coded patient ID bracelets, a hospital-wide system can track inventory, create accurate and current patients' bills, and even verify the timing and dosage of medications at the bedside. All told, since the

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[4/] Plessey makes leap with wireless LAN, Electronic Engineering Times, Issue 822 at 1 (Nov. 7, 1994).

Commission authorized spread spectrum under Part 15,[5] commercial users of "indoor" spread spectrum radio products for data collection have invested over $500 million, with a current annual growth rate of between 30 and 50 percent.[6] Although most of these applications are invisible to consumers, their impact nonetheless shows up clearly at the checkout stand in the form of lower prices, and also in the United States' competitive edge in global markets.

7. "Outdoor" spread spectrum systems are now widely used for intracity data relay and are especially valuable where spectrum for more conventional technologies, such as microwave, is congested or unavailable. Moreover, utility companies will soon have invested almost a billion dollars in spread spectrum automatic meter reading equipment.[7] There is also a burgeoning market for spread spectrum consumer products, including cordless telephones, wireless speakers, wireless headsets, wireless VCR-to-TV transmission, and long-range remote controls.[8]

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[5] Spread Spectrum Systems, 101 F.C.C.2d 419 (1985).

[6] These figures are computed from Symbol's own sales divided by its market share as published in industry references.

[7] This information comes from a survey of gas and electric companies conducted by the Utilities Telecommunications Council. The 45 responding companies represent only a fraction of the gas and electric utilities providing service to the public nationwide. (Data provided by Utilities Telecommunications Council on Nov. 17, 1994.)

[8] Many of the applications described in text (other than wireless LANs) presently operate in the 902-928 MHz band. However, a survey of the FCC's recent public notices shows a sharp upturn in certification grants for 2.4 GHz equipment. This (continued...)

Current Rule

8. Section 15.247(a)(1)(ii) of the Rules provides:

> Frequency hopping systems operating in the 2400-2483.5 MHz and 5725-5850 MHz bands shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.

As a practical matter, the 1 MHz bandwidth limit restricts data rates to about 1 megabit/second. Typical wired LANs, by contrast, operate at ten times that speed. (See Appendix A.) Although it is possible to push the data density above 1 megabit/MHz, doing so requires equipment that is too costly and sophisticated for ordinary office equipment. As a result, the 1 MHz bandwidth limit is likely to hinder the widespread deployment of wireless LANs.

9. Moreover, the present rules may prove to be incompatible with the Commission's proposal to auction 2402-2417 MHz for commercial use.[9/] A system using the present maximum 1 MHz channel bandwidth and the required 75 hopping frequencies must occupy a total bandwidth of at least 75 MHz. The 2400-2483.5 MHz band provides enough room for this operation, but with only 8.5 MHz to spare. Thus, frequency hopping systems

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[8/](...continued)
presages greatly increased activity at 2.4 GHz. It is important for the Commission to correct problems with the existing rule at 2.4 GHz while manufacturers are still at the planning stage for new products for that band.

[9/] Notice in ET Docket No. 94-32.

that comply with the present rules cannot avoid intruding on the 2402-2417 MHz sub-band, in which the Commission proposes to give users complete discretion over such fundamental technical characteristics as channelization, signal strength, modulation techniques, and antenna characteristics.[10/] Not only might this overlap adversely impact spread spectrum operations but the presence of spread spectrum transmitters in the sub-band may reduce the value of the 2402-2417 MHz to commercial users, and hence may reduce the funds raised at auction.[11/]

Proposal

10. Symbol requests the following amendment to Section 15.247(a)(1)(ii). New material appears in bold type:

> (ii)**(A)** Frequency hopping systems operating in the 2400-2483.5 MHz and 5725-5850 MHz bands shall use at least 75 hopping frequencies. The maximum 20 dB bandwidth of the hopping channel is 1 MHz. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.
>
> **(B) As an alternative to paragraph (A), frequency hopping systems operating in the 2400-2483.5 MHz and 5725-5850 MHz bands may use at least 15 hopping frequencies whose 20 dB**

[10/] Id. at ¶ 10. The only constraint on users would be an obligation to prevent interference to "other users," id., but the protected category does not necessarily include Part 15 spread spectrum users. See 47 C.F.R. § 15.5(b). Indeed, one proposed option is to "eliminat[e] this band from Part 15 use in order to avoid any potential conflicts with future licensed services[.]" Notice in ET Docket No. 94-32 at ¶ 18.

[11/] The proliferation of spread spectrum devices at 2.4 GHz will make it increasingly difficult for users of other services to identify an interfering spread spectrum transmitter -- a problem that will be exacerbated by the adoption of an IEEE standard for wireless LANs.

bandwidths do not overlap. The average time of occupancy on any frequency shall not be greater than 0.4 seconds within a 30 second period.[12/]

11. This change promises several advantages. First, the proposed language is compatible (though not identical) with the European Telecommunications Standards Institute standard ETS 300-328 for the 2.4 GHz band.[13/] By enabling manufacturers to produce the same equipment for domestic and European use, the new rule will reduce costs to U.S. manufacturers seeking to enter international markets, and hence should contribute to an improved balance of trade with Europe. Second, by offering manufacturers and users greater options as to bandwidth, the rule change will make it possible for wireless computer networks to compete with wired LANS in both cost and speed, while offering the wireless advantages of portability and flexibility.[14/] Third, and

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[12/] Paragraph (A) is no longer strictly necessary, because equipment operating under paragraph (B) will also comply with paragraph (A); that is, paragraph (A) is a special case of paragraph (B). Symbol nonetheless urges the Commission to leave paragraph (A) intact to reassure readers who lack technical training that products manufactured in accordance with the present rule will satisfy the proposed rule as well.

[13/] The European standard ETS 300-328 applies over 2400-2483 MHz and requires 20 hops. The Japanese standard RCR STD-33 requires only 10 hops and applies over the much narrower bandwidth of 2471-2497 MHz. Symbol does not seek compatibility with the Japanese standard.

[14/] The proposed change will also partially correct a competitive disparity between direct sequence systems and frequency-hopping systems. Direct sequence systems must have a processing gain of at least 10 dB. 47 C.F.R. § 15.247(e). In consequence, a direct sequence system can carry a signal bandwidth one-tenth as wide as its total occupied bandwidth, or about 8 MHz in the 2400-2483.5 MHz band. The proposed change would raise the effective signal bandwidth of frequency-hopping

(continued...)

particularly important, the proposal will not significantly detract from the major advantages of spread spectrum long recognized by the Commission: its ability to enhance spectrum efficiency by sharing spectrum with other services in ways that minimize cross-interference.[15/] (See Appendix A for a technical discussion.) Finally, the proposed change will permit spread spectrum systems to operate at commercially viable data rates whether or not the 2402-2417 MHz sub-band remains available for their use.

12. The Commission tailored the present rules in part to "allow operation of equipment such as wireless local area networks that depend on high speed transmission of data."[16/] The amendment requested here will directly further that objective without prejudice to other users of the spectrum.

[14/](...continued)
systems from 1 MHz to about 5 MHz, making such systems better able to compete with direct sequence systems.

[15/] Spread Spectrum Systems, 5 FCC Rcd 4123, 4123 at ¶ 2 (1990). See also Spread Spectrum Systems, 101 F.C.C.2d 419 (1985). Although the 2400-2483.5 MHz band is not heavily used for communications at present, that may change in response to the fast-growing demand for spectrum at wavelengths suitable for mobile services. As noted above, the Commission has already proposed to auction 15 MHz of the band for commercial services. Notice in ET Docket No. 94-32.

[16/] Spread Spectrum Systems, 5 FCC Rcd 4123, 4126 at ¶ 19 (1990).

CONCLUSION

13. For the reasons presented, the Commission should commence a rule making proceeding to amend Section 15.247(a)(1)(ii) of its rules as proposed above.

Respectfully submitted,

Peter Tannenwald

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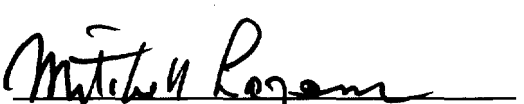

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Counsel for
Symbol Technologies, Inc.

December 6, 1994

Appendix A

Technical Discussion

The driving constraints on development of a wireless computer network are speed and cost. The predominant computer networks now in use are Ethernet and Token Ring, standardized by the Institute of Electrical and Elecronic Engineers ("IEEE") specifications IEEE 802.3 and IEEE 802.5, respectively. The Ethernet data rate is 10 Mbps, although fast Ethernet at 100 Mbps is quickly becoming popular. Token Ring operates at either 4 or 16 Mbps. A viable wireless computer network must provide performance comparable to that of the wired networks now in use. Moreover, a viable wireless network cannot cost much more than the current wired networks. The costs of the Ethernet and Token Ring are both low, with Ethernet electronic boards commonly selling for less than $150.

More than 50 companies, large and small, are participating in the IEEE 802.11 standardization group for wireless computer networks. IEEE 802.11 specifies a minimum data rate of 1 Mbps with an alternative standard at 2 Mbps. Other alternatives with higher data rates are also under consideration.

The 2400-2483.5 MHz band under § 15.247 is the choice of IEEE 802.11, as it has been the choice for almost all other wireless computer network development. Section 15.247(a)(1)(ii) limits the signal bandwidth to 1 MHz and requires a minimum of 75 hops. Taking computer network speed requirements into account, these constraints effectively require systems to occupy at least 75 of the 83.5 MHz available. Reducing the number of required hops for frequency hopped system will allow the development of higher data rate systems that meet customer speed demands while still maintaining the sharing aspects intended by § 15.247 spread spectrum technology, and will also avoid any conflict with proposed commercial services at 2402-2417 MHz.

The considerations that affect spectrum sharing for frequency hopping systems are the channel access method, receiver filter effectiveness, number of hops, and dwell time. Access method and receiver filtering are not specified by § 15.247, although they have been addressed by groups like IEEE 802.11 and WinForum (for the unlicensed PCS band). The amount of interference caused by a frequency hopping system to a stationary signal depends in part on the fraction of time, or duty cycle, that the two share the band occupied by the stationary signal. That duty cycle is:

overlap duty cycle =

INTEGER[(stationary BW)/(hopper BW)] / (no. of hops)

The INTEGER function rounds up a fractional argument to the next highest integer. This has the effect of assuming a worst case

condition in which the hopping signal completely overlaps the stationary signal. The effect of the INTEGER operation is greatest when the hopper bandwidth is much larger than the stationary signal bandwidth.

The effect of reducing the number of hops is relatively small for wide band stationary signals, but becomes more pronounced for stationary bandwidths that are much narrower than the hopper bandwidth. For example:

Wideband stationary signal. Suppose the stationary signal uses 20 MHz of over-the-air bandwidth (for example, an IEEE 802.11 direct sequence system at a 2 Mbps data rate with processing gain of 11). The overlap duty cycle is:

Current rules

overlap duty cycle = INTEGER(20/1)/75 = 26.7%

Proposed rules

overlap duty cycle = INTEGER(20/5)/15 = 26.7%

Narrowband stationary signal. Suppose the stationary signal uses a 1 MHz bandwidth.

Current rules

overlap duty cycle = INTEGER(1/1)/75 = 1.3%

Proposed rules

overlap duty cycle = INTEGER(1/5)/15 = 6.7%

In this example the decreased number of hops does not result in additional interference to the wideband stationary signal. Although the overlap duty cycle increases for the narrowband stationary signal, the absolute percentage (6.7% in this example) remains very low. If the system uses a carrier sense ("listen-before-talk") protocol, a shorter dwell time will improve the sharing characteristics. Both IEEE 802.11 and WinForum require a listen-before-talk protocol.

With fewer hops, a system can avoid larger portions of the band that may be incompatible with spread spectrum while still maintaining its data rate and without significantly increasing interference to other users. In fact, fewer hops can actually reduce interference to stationary signals if the users coordinate frequency usage to minimize or eliminate overlap.

The current rules do not specify a minimum bandwidth. The total occupied bandwidth is constrained only by the

implementation of the frequency synthesizer which determines the resulting phase noise and therefore the 20 dB bandwidth. This will still be true with the alternative rule. In both cases, improvements in phase noise will reduce the minimum bandwidth required. For example, a system with low phase noise and 75 hops can use less bandwidth than a system with higher phase noise and 15 hops. Therefore, we do not propose to add new rules on minimum bandwidth.

For direct sequence systems, the amount of interference reduction is determined on the receive side by the jamming margin in the receiver, and on the transmit side by spreading the power to reduce the overall power spectral density. Section 15.247(e) requires a minimum processing gain of 10 dB, which equates to an over-the-air bandwidth 10 times wider than the data rate requires. That processing gain is quite low compared to the currently required 75 hops and the proposed 15 hops, so no change is proposed here for direct sequence systems. In the 2400-2483.5 MHz band, direct sequence systems can achieve a data rate of approximately 8 Mbps. The rule proposed here will help to bring frequency hopping systems into parity with direct sequence systems.

VERIFICATION

I have read the foregoing Petition for Rule Making of Symbol Technologies, Inc. I declare under penalty of perjury that the facts stated therein are true and correct to the best of my knowledge and belief. Executed on November 23, 1994.

Raymond A. Martino
Director RF Engineering
Symbol Technologies, Inc.